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MINIATURIZED THERMOELECTRIC POWER SOURCES

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Abstract

Advanced thermoelectric microdevices integrated into thermal management packages and low power, electrical power source systems are of interest for a variety of space and terrestrial applications. By making use of macroscopic film technology, microgenerators operating across relatively small temperature differences can be conceptualized for a variety of high heat flux or low heat flux heat source configurations. The miniaturization of state-of-the-art thermoelectric module technology based on Bi_2Te_3 alloys is limited due to mechanical and manufacturing constraints for thermoelement dimensions (100-200 μm thick minimum) and number (100-200 legs maximum). We are developing novel thermoelectric microdevices combining high thermal conductivity substrate materials such as diamond or even silicon, thin film metallization and patterning technology, and electrochemical deposition of 10-50 μm thick thermoelectric films. By shrinking the size of the thermoelements and increasing their number to several thousands in a single structure, these devices can generate high voltages even at low power outputs that are more compatible with electronic components. Miniature power systems taking advantage of waste heat sources or organic fuel heat sources and combined with energy storage devices for enhanced performance are particularly attractive for terrestrial applications. Some details about the fabrication of the miniature devices are described.

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